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Title:

SYSTEM FOR AND METHOD OF REMOVING OR PREVENTING ELECTROSTATIC CHARGES FROM AN ORGANIC PHOTOCONDUCTOR DURING TRANSIT

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SYSTEM FOR AND METHOD OF REMOVING OR PREVENTING ELECTROSTATIC CHARGES FROM AN ORGANIC PHOTOCONDUCTOR DURING TRANSIT

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present invention is a continuation of and claims priority to copending and commonly assigned United States patent application serial number 10/172,943 entitled, "System For And Method Of Removing or Preventing Electrostatic Charges From An Organic Photoconductor During Transit," filed June 17, 2002, the disclosure of which is hereby incorporated herein by reference.

FIELD OF INVENTION

[0002] The present invention is generally related to toner cartridges in imaging devices and specifically to the reduction or elimination of electrostatic charge buildup on toner cartridges during transit.

DESCRIPTION OF RELATED ART

[0003] Currently there are several types of technologies used in printing and copying systems. Electrophotographic printing devices such as laser printers and copiers use toner particles to form the desired image on the print medium, which is usually some type of paper. Once the toner is applied to the paper, the paper is advanced along the paper path to a fuser. In many printers, copiers and other electrophotographic printing devices, the fuser includes a heated fusing roller engaged by a mating pressure roller. As the paper passes between the rollers, toner is fused to the paper through a process of heat and pressure.

[0004] FIGURE 4 is a diagram of typical laser printing device 400 employing an electrophotography (EP) process. For monochromatic printing, a single color of toner particles 401 (e.g., black) are held in toner supply hopper 402. Toner particles 401 are typically small plastic (*e.g.*, styrene) particles on the order of 5 microns (10^{-6}) meter in size. Agitator, or stirring blade, 403 is typically made of plastic or mylar and ensures toner particles 401 are uniformly positioned along developer sleeve 404 while inducing a negative charge onto the toner particles in the range of -30 to -40 micro coulomb per gram (μc/g). Developer sleeve 404 rotates in a counterclockwise direction about an internal stationary magnet 405 which acts as a shaft. Toner particles 401 are attracted to the rotating developer sleeve 404 by the magnetic forces of

stationary magnet 405. Doctor blade 406 helps in charging toner particles 401 and meter out a precise and uniform amount of toner particles 401 onto developer sleeve 404 as its outer surface rotates external to toner supply hopper 402. Developer sealing blade 407 removes excess toner particles 401 affixed to developer sleeve 404 as its outer surface rotates back into toner supply hopper 402.

[0005] Primary charging roller (PCR) 408 conditions organic photoconductor (OPC) drum 409 using a constant flow of current to produce a blanket of uniform negative charge on the surface of OPC drum 409. Production of the uniform charge by PCR 408 also creates the effect of erasing residual charges left from the previous cycle.

[0006] A major component of the EP process is OPC drum 409. OPC drum 409 is a thin-walled aluminum cylinder coated with a photoconductive layer. The photoconductive layer may constitute a photodiode that accepts and holds a charge from PCR 408. Initially, the unexposed surface potential of the OPC is approximately -600 volts. Typically, the photoconductive layer comprises three layers including, from the outermost inward, a charge transport layer (CTL), charge generation layer (CGL), and barrier or oxidizing layer formed on the underlying aluminum substrate. The CTL is a clear layer approximately 20 microns thick, which allows light to pass through to the CGL and controls charge acceptance to the OPC. The CGL is about 0.1 to 1 micron thick and allows the flow of ions. The barrier layer bonds the photoconductive layer to the aluminum substrate

[0007] Laser beam 410 exposes OPC drum 409 one line at a time at the precise locations that will receive toner (paper locations which correspond to the image being printed). OPC drum 409 is discharged from -600V to approximately -100V at points of exposure to laser beam 410, creating a relatively positively charged latent image on its surface. Transformation of the latent image into a developed image begins when toner particles 401 are magnetically attracted to rotating developer sleeve 404. Alternatively, if nonmagnetic toner is used, developer sleeve 404 may comprise a foam roller to mechanically capture toner particles 401. In this case, an open cell foam roller may be included to apply toner to developer sleeve 404. The still negatively charged toner held by developer sleeve 404 is attracted to the relatively positively charged areas of the surface of OPC Drum 409 and "jumps" across a small gap to the relatively positively charged latent image on OPC drum 409 creating a developed image.

[0008] Paper to receive toner from OPC drum 409 is transported along paper path 411 between OPC drum 409 and transfer roller 412, with the developed image transferred from the surface of OPC drum 409 to the paper. The transfer occurs by action of transfer roller 412 which applies a positive charge to the underside of the paper, attracting the negatively-charged toner particles to move to the paper. Wiper blade 413 cleans the surface of the OPC drum 409 by scraping off the waste (untransferred) toner into waste hopper 415, while recovery blade 414 prevents the waste toner from falling back onto the paper. Fusing occurs as the paper, including toner particles, is passed through a nip region between heated roller 416 and pressure roller 417 where the toner is melted and fused (or "bonded") to the paper. Heated roller 416 and pressure roller 417 are together referred to as the fuser assembly.

[0009] During shipping of an ink cartridge, internal parts such as OPC drum 409, PCR 408, transfer roller 412, and developer roller 404, may rub relative to each other thereby creating static charges. Large static charges may become trapped in the organic photoconductor (OPC) on OPC drum 409 and cause a defect in printer operations when the toner cartridge is positioned in an imaging device such as a printer or copier. This effect is called "plus charge memory" or "rubbed memory." Rubbed memory may be negative or positive. A negative change trapped inside of the organic photoconductor will create a repelling action leaving a portion of OPC drum 409 uncharged. Uncharged portions of OPC drum 409 may result in non-printed areas on the printed page.

[0010] During normal operation PCR 408 is arranged to uniformly charge the surface of OPC drum 409. However, the charge trapped during transit in the organic material of OPC drum 409 disrupts the constant charge field transferred from PCR 408. This causes a non-uniform charge across the surface of OPC drum 409 resulting in uneven print density and other defects on the printed pages. Thus, to eliminate these printing defects it is necessary that a constant charge be applied to OPC drum 409 prior to modulation of the charge by a laser or projected image.

BRIEF SUMMARY OF THE INVENTION

[0011] The present invention is directed to a system which uses a removable cover to isolate an organic photoconductor from at least one other component of a toner cartridge. The present invention also includes a method of reducing electrostatic charge on a photoconductor

including the steps of isolating the photoconductor from other components in a toner cartridge with a removable cover, removing the removable cover prior to insertion of the toner cartridge into an electrophotographic printing device and inserting the toner cartridge into the device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIGURE 1 is a side view of a simplified cartridge in cross-section with a removable cover according to the present invention in place;

[0013] FIGURE 2 shows a flow diagram of a method of reducing or eliminating plus charge memory;

[0014] FIGURE 3 is a perspective view of a cover for an OPC drum including a conductive layer according to an embodiment of the invention;

[0015] FIGURE 4 is a side view of a simplified cartridge cross-section of the prior art; and

[0016] FIGURE 5 is a cross-section of a cover material including a conductive layer.

DETAILED DESCRIPTION

[0017] During shipping and handling of toner cartridges, vibrations cause various components of a toner cartridge to rub against each other possibly resulting in a buildup of electrostatic charges. These electrostatic charges may become trapped inside or on the photoconductor roller such as OPC 102 (FIGURE 1). The present invention prevents or eliminates these electrostatic charges by mechanically and electrically insulating the roller from surrounding structures of the toner cartridge. The reduction or elimination of these charges prevents or reduces defects on printed materials resulting from the accumulation of these charges.

[0018] Extensive efforts have been directed to minimize the type and extent of rubbing between components with packaging design changes and boxes designed to reduce vibrations. The present invention isolates one of the components, preferably by enveloping that component in a packaging material preferably a resilient foam, or similar electrically isolating

material, such as a thin film during shipping. This material is designed to be easily removed prior to or as part of inserting the cartridge into the printer.

[0019] This insulated packing layer may also be connected to an existing toner dam provided in toner cartridges. Removal of this toner dam is required to start the toner to flow into the developer area. Typically, a pull tab is connected to the internal toner dam that must be removed before the toner cartridge is used in the printer. Similarly, a temporary protective removable cover (hereinafter simply a "removable cover") of the present invention must also be removed before the toner cartridge is inserted into the printer or at least prior to use of the cartridge should removal be possible after insertion and installation.

[0020] The removable cover preferably slides in-between the OPC and any other component which may contact it. The present invention may further include an electrical connection to a ground to drain charges which may build up on the cover. This may be accomplished by laminating conductive material, such as an aluminum film, to the removable cover.

[0021] The removable cover functions to reduce or eliminate high voltage electrostatic charges on the order of 250 or more volts. Voltages of this magnitude may be caught or trapped in the organic materials of the OPC drum. Used in combination with electrical drains included in the packaging and/or the chassis of the printer, the removable cover bleeds off most or all of this static charge to reduce or eliminate charges trapped in or on the OPC drum.

[0022] Referring to FIGURE 1, removable cover 101 is installed during assembly so as to almost completely encircle OPC 102, positioned between OPC 102 and one or more of the following components: primary charge roller (PCR) 103, cleaning blade 104, wiper blade 105, transfer roller 106, and developer roller 107. As its primary function, removable cover 101 isolates OPC 102 from these other components to reduce or eliminate the generation of static charges. Removable cover 101 may be made of a foam material such as polyurethane and may include a conductive laminate made of, for example, an aluminum film. The cushioning provided by the foam of removable cover 101 helps dampen vibration between the components. The removable cover may also drain away to ground any remaining charge generated by components rubbing together if the conductive laminate is included. Thus, the conductive layer is grounded to packaging material (not shown in FIGURE 1, but constructed to make electrical

contact with contact cover 101 during transit.) so that any electrostatic charge drains off away from OPC Drum 102 to ground.

[0023] Removable cover 101 may be connected to toner dam 108 (connection not shown), by a tab or other structure. During shipping, both removable cover 101 and toner dam 108 remain in place and are only removed immediately before the cartridge is installed into the printer or, after installation if the configuration permits. Removable cover 101 may be removed in a direction indicated by arrow 109 and toner dam 108 may be removed in a direction indicated by arrow 110. If the two are interconnected, as discussed above, removal of one will serve to remove the other.

[0024] FIGURE 2 is a diagram of a method of reducing or eliminating charge memory, a component of a printing system. In step 201 an insert, such as a foam insert, is placed between organic photoconductor drum 102 (FIGURE 1) and at least one other system component which together with the OPC drum may generate an electrostatic charge during shipment. In a preferred embodiment removable cover 101 (FIGURE 1) electrically isolates OPC Drum 102 from all other system components. An insert tab may be included on the insert to assist in its removal. This insert tab may be connected to the pull tab preventing toner leakage during shipment or transit in step 201. As discussed, the removable cover may include a conductive layer 302 (FIGURE 3) which is attached to ground in step 203. The toner cartridge is shipped in this protected shipping configuration in step 204. Before the toner cartridge is used, the removable cover is removed (step 205) together with the toner dam (step 206). If the Foam Insert 101 is connected to toner dam 108, these may be removed simultaneously. A single pull tab (not shown) may be connected to both toner dam 108 and Foam Insert 101 for ease of removal. In step 207 the toner cartridge is placed in the printer and the printer is operated in step 208.

[0025] FIGURE 3 shows one possible construction of an alternate embodiment 300 of the removable cover including a laminated construction. In this embodiment the inner foam characteristics 301 of one laminate helps absorb vibration and provides a physical barrier between components and the conduction properties of a second Conductive Layer 302 acts to drain to ground any built up static charges. Alternatively, removable cover 300 may be composed of a conductive laminate foam formed on both sides. End 303 of removable cover 300 slides into the cartridge.

[0026] FIGURE 5 shows a cross section of a cover material including a conductive layer, 501.